

EARLY FAECAL EXCRETION OF INHALED PLUTONIUM

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INTRODUCTION

The MOX fuel fabrication facility and the spent fuel reprocessing plant are operated at JNC Tokai Works. At these facilities, a large amount of plutonium, uranium and fission products are processed. Radiation monitoring has been performed extensively to protect workers from an excessive exposure. Internal monitoring has been taken into consideration for workers engaged in plutonium processing. In the case of an incident involving air contamination or body surface contamination, nasal smear sampling is carried out immediately as screening to check whether there is a significant intake or not.

SPECIAL MONITORING FOR PLUTONIUM INHALATION

Operational flow of the special monitoring for plutonium inhalation at JNC Tokai Works is shown in Figure 1. Nasal smear, lung monitoring, faeces analysis and urine analysis are main procedures in the special monitoring. Their procedures are described in detail as below.

(1) Nasal smear

If there is the possibility that a worker inhaled plutonium, contamination in the nasal cavity is measured by nasal smears as soon as possible.

A filter paper wrapped around the end of a stick is used for nasal smear and deposited particles are taken from nasal cavities. The filter paper removed from the stick is placed on a stainless plate and dried by an infrared lamp after collection.

The activities of these nasal smear samples are measured by a ZnS(Ag) alpha-scintillation counter. The minimum detectable activity (MDA) for alpha emitters is about 0.07 Bq/sample in 5 minutes counting, which is also corresponded to the screening level for the next procedures

(2) Lung monitoring

Second procedure is lung monitoring to estimate the amount of plutonium deposited in the respiratory tract. Four High-Purity Germanium semiconductor detectors for low energy photons are used with the lung counter. The MDA of ^{239}Pu deposited in the lungs is about 1 kBq in 30 minutes counting for 2.1 cm chest wall thickness, which is about 10 times larger than the annual limit intake (ALI) of ^{239}Pu recommended by ICRP Publication 30. Therefore, lung monitoring is carried out for evaluating excessive inhalation requiring the medical treatment like DTPA (Diethylene Triamine Pentaacetic Acid) therapy. If inhaled plutonium compounds include ^{241}Am , the MDA is improved to around 10 Bq.

(3) Faeces and urine analyses

Faeces and urine analyses are carried out as a third procedure^{2), 3)} in the special monitoring. Faecal samples are incinerated, dissolved in nitric acid and treated with an anion exchange method, and plutonium is deposited electrically on a stainless steel plate. Alpha activity for plutonium in the sample is measured by an alpha spectrometer, which consists of a Silicon semiconductor detector. The MDA of ²³⁹Pu is 3.7 mBq/sample in 15 hours counting.

RESULTS AND DISCUSSION

As a result of analysis for investigated 59 inhalation cases of Pu, the ratio of the total alpha activity observed in faeces for the first 5 days after an inhalation to the alpha activity observed in nasal smears shows approximately a lognormal probability distribution. This activity ratio is shown in Figure 2. The cumulative probability is more than 95% at the activity ratio of 100. The range of the distribution for the activity ratio is wide due to the difference of plutonium deposition patterns in the respiratory tract, which depends on particle size distribution, chemical form and removal efficiency of nasal smear.

According to the latest ICRP biokinetic model calculated on the new respiratory tract model of ICRP publication 66⁴⁾, there is a slight difference of the total activity in the early excretion in faeces due to the difference of “Type”, which expresses the degree of absorption into body fluids from the respiratory tract. However, the difference of a particle size influences a total amount of an alpha activity in the early excretion in faeces significantly. A total amount of alpha activity in the early-excreted faeces due to large particles is larger than that of small particles.

CONCLUSION

As a result of the special monitoring for plutonium inhalation cases at JNC Tokai Works, some informative knowledge are obtained. Nasal smear is effective way to estimate a potentially high intake of plutonium in our experience. If there is the possibility that a worker inhaled plutonium, nasal smear sampling is carried out. Applying 100 as the ratio for an incident of plutonium inhalation, an intake of plutonium can be estimated conservatively and immediately without waiting for fecal bioassay results. This preliminary estimation is used to decide whether to perform the medical procedure in case of excessive inhalation.

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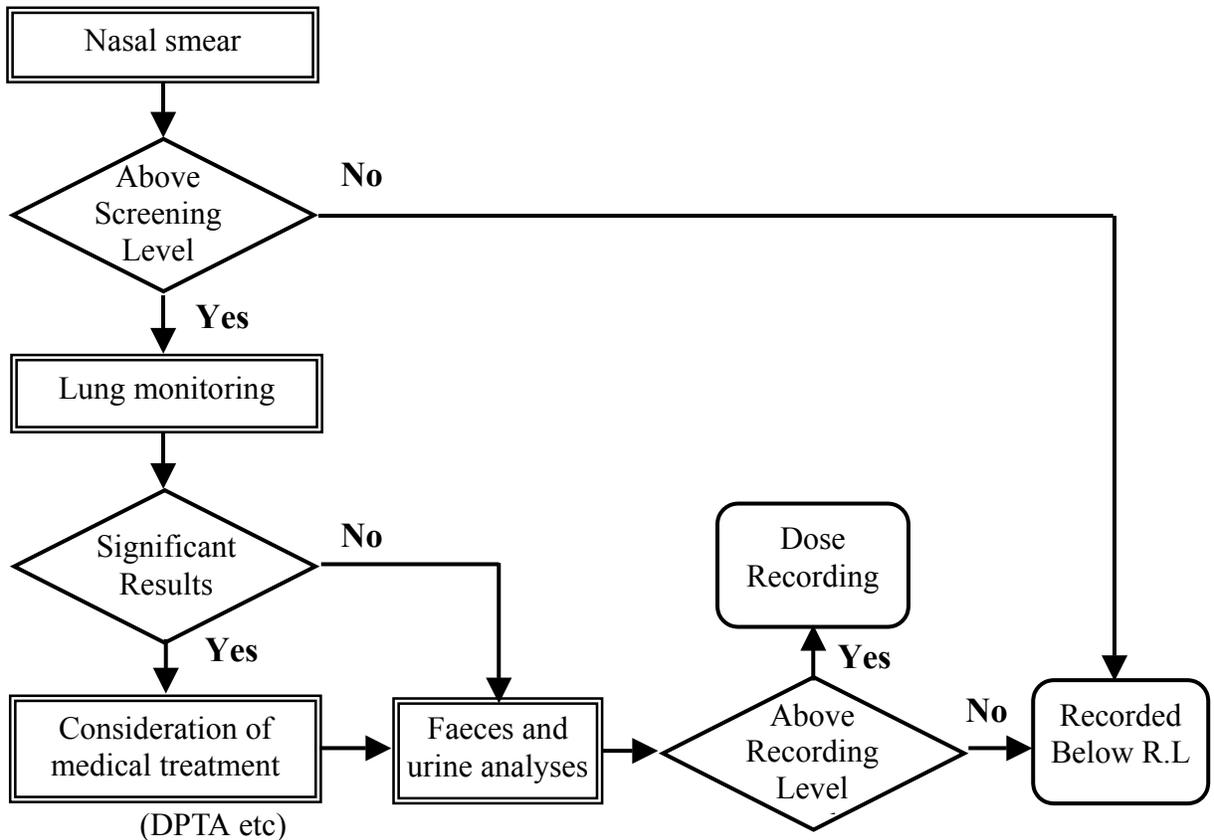


Figure 1 Operational flow of special monitoring for Pu inhalation

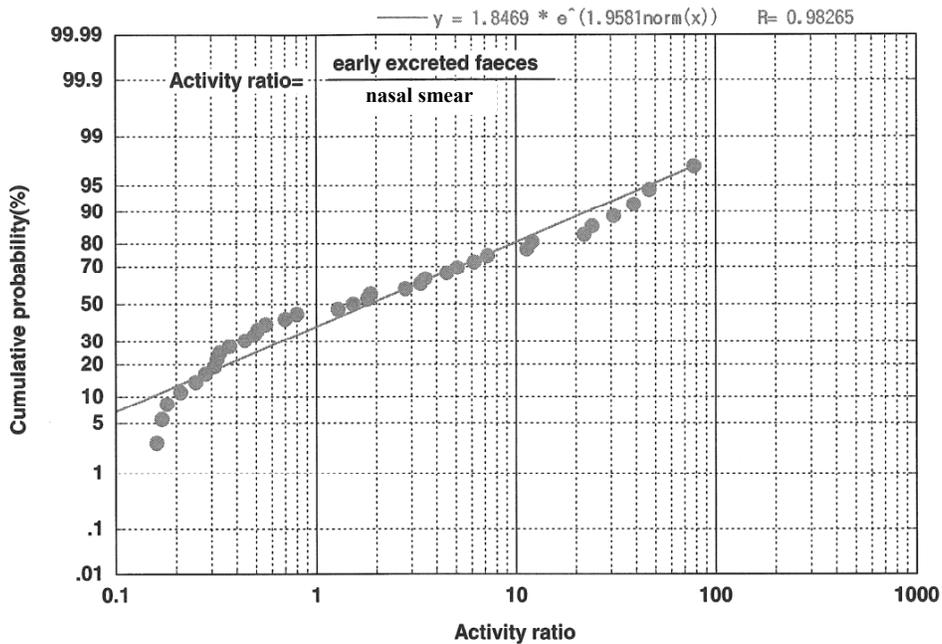


Figure 2 Cumulative probability of the Pu activity ratio between an early excreted faeces sample (5days) and nasal smear sample